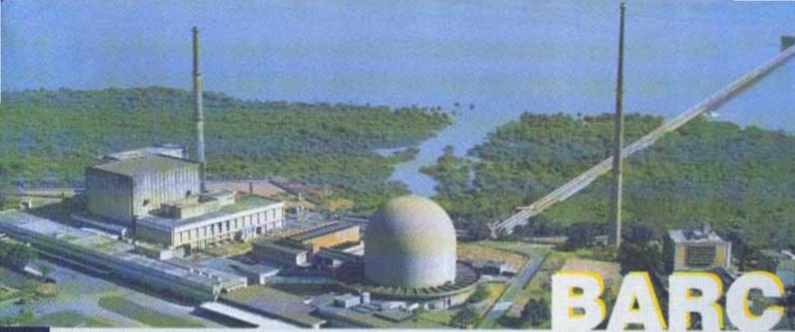

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BARC NEWSLETTER

Contents

THERMAL ANALYSIS DATA STATIONS FOR CHARACTERIZATION OF MATERIALS AND PROCESSES

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Introduction

Thermo-analytical techniques provide an established methodology for characterization of materials and studying the thermodynamics of various processes involved in diverse fields spanning industry as well as research. In these techniques, the sample under investigation is subjected to a programmed cycle of heat/cool/isothermal segments in a controlled ambience in a furnace, and precise measurements are done on the changes occurring in different parameters of interest as a function of temperature. The profiles of these parameters characterize the physico-chemical phenomena occurring with temperature.

There are many thermal analysis instruments in use in BARC and other DAE (Department of Atomic Energy) units in diverse areas of metallurgical and chemical engineering, chemistry and materials science. These instruments are based on different experimental techniques, namely, Differential Scanning Calorimetry (DSC), Differential Thermal Analysis (DTA), Thermo-Gravimetry (TG) and Thermo-Mechanical Analysis (TMA). Such systems, each typically costing several tens of lakhs of rupees, are also used extensively in industry and required in universities. Many of these instruments are severely limited in their data handling capabilities, being of pre-PC/Windows design. Either a fixed data processing functionality is rigidly embedded within the instrument, or a compatible workstation is available at a very high cost, being proprietary in nature. A great need is therefore felt by users for a computerized workstation that can acquire and comprehensively process data from such instruments.

With this in view, some PC-based Thermal Analysis Data Stations (TADS) have been developed at Computer Division, BARC, for enhancing the functionality of such apparatuses in different laboratories in DAE. The systems developed are:

1. *DSC / TG Thermal Analysis Data Station* : for simultaneous Differential Scanning Calorimetry and Thermo-Gravimetry
2. *TG / DTA Thermal Analysis Data Station*: for Thermo-Gravimetry with Differential Thermal Analysis
3. *TMA / TG Thermal Analysis Data Station*: for Thermo-Mechanical Analysis (dilatometry) with Thermo-Gravimetry

TMA-DSC-TG-DTA system at Waste Management Facility, Tarapur

DTA system at Fuel Chemistry Division, BARC

These systems in different configurations have been installed at several labs: Waste Management Facility at Tarapur, Fuel Chemistry Division, Post Irradiation Examination Division, Materials Processing Division (2 systems), Solid State Physics Division and Applied Chemistry Division at BARC. More installations are under way including at Analytical Chemistry Division, Radio Metallurgy Division, IGCAR and Gorakhpur University.

DSC system at Post Irradiation Examination Division, BARC

Background

In Differential Scanning Calorimetry (DSC), the sample and an inert reference material are subjected to an identical thermal regime. At the point of any reaction or a transformation, a heat flux is generated in the sample which corresponds to the energy associated with that phenomenon, which can be exothermic or endothermic. Precise measurement is done on this heat flux signal which is picked up employing different measurement techniques and assuming different thermodynamic models of the experimental set-up. The thermal effects are captured as peaks or transitions on temperature or time scale whose parameters characterize the active material, both qualitatively and quantitatively.

In Differential Thermal Analysis (DTA), a temperature differential between the sample and the reference is manifested corresponding to the energy of reaction. The microvolt level differential temperature signal is then picked up using thermocouples and analyzed to characterize the reaction.

Thermo-Gravimetry (TG) captures and profiles changes in mass associated with the reactions during the temperature cycling. In Thermo-Mechanical Analysis (TMA) based on dilatometry, on the other hand, dimensional changes as a function of temperature are studied.

Many times one single technique does not yield sufficient analytical information for proper characterization, and two methods are used simultaneously, e.g., DSC with TG, TG with DTA. The DSC technique generally yields extensive information about the process and is in wide use in the industry.

The Experimental Set-up

The basic thermal analysis apparatus comprises a furnace, experiment control electronics and the signal processing hardware/software (Fig.1). The furnace houses the primary measuring cell which holds crucibles for sample and reference materials along with data probes in accordance with the technique employed, e.g. micro-thermobalance, heat flux sensors, thermocouples, etc. The ambience is controlled by an atmospheric gas flow. Multi-segment programmed temperature control of the furnace and the primary signal pick-off for the parameters of interest are implemented through specialized instruments manufactured by several companies. The parameter signals, mostly processed through hardware, are conventionally given out on a multi-pen strip chart recorder. In the designs available till lately, the machine control and signal handling is either hardwired, or implemented through an embedded or intimately-coupled processor. A fixed, limited data processing is built into the instrument and much data interpretation needs to be done external to the system, often from a recorder hardcopy. Many of these instruments do not provide any external link, either standard or proprietary, for coupling any computer-based data station to it.

The Data Station (TADS)

The present development implements generalized data acquisition and processing systems for use with different thermal analysis instruments without being specific to any particular instrument model. The TADS consists of a hardware acquisition unit and a PC/Windows based software package. It couples to the instrument non-invasively and in parallel by tapping the available signals from the instrument, typically the low-level signals at the recorder point. The data acquisition hardware module handles signal conditioning, hardware configuring, digital conversion and communication with the PC. In cases where no analog signal outlet exists in any form on the instrument, the software

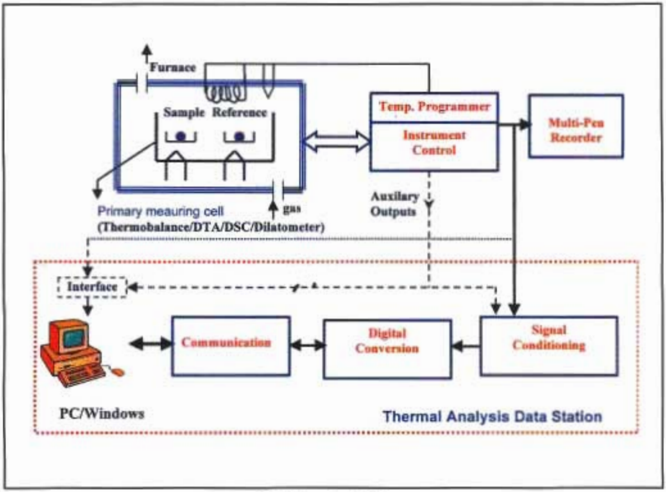

Fig. 1 Experimental Set-up

package can be utilized through a data import utility for processing of spectral data acquired separately.

The data station can acquire three parameters at a time: Temperature, DTA/DSC/TMA, and TG, and it generates the derivative profile of one primary parameter internally. Extensive data analysis, manipulation and presentation features are provided, which can run concurrently with a fresh acquisition in the background under Windows environment through a user-friendly graphical interface.

Features

Basic System Operation

- Non model-specific. It can couple to different instruments non-invasively for data acquisition in parallel.
- Acquisition of three parameters: Temperature, DTA or DSC or TMA, and TG, with a derivative profile generated internally.
- Concurrent processing of earlier and current experiments with fresh data acquisition in background.

Data Analysis Functions

- Peak evaluation for net peak area, net height, location, onset-, end- and peak temperatures, enthalpy and peak width.
- 6 types of baselines with interactive definition for approximating the system dynamics during the reactions: linear, intersecting tangents, stepped, horizontal from start or end point, and drop to zero. Other types like fitted-curve baseline are being added.

- TG mass-change profile: between computed reaction temperatures with baselines defined by tangents or curve fitting in pre- and post-reaction region.
- Glass transition temperatures.
- Background stripping using blank crucible data.
- TMA elongation profile.
- Enthalpy regression with respect to temperature and heating rate.
- Temperature correction for zero heating rate. Other functions like specific heat computation are being added.

Spectrum Handling Utilities

- Smoothing using conventional or fuzzy logic based algorithms for noise suppression.
- Unwrapping of thermograms where the signal folds over its dynamic range, with auto/manual detection of break-point.
- Summation / subtraction of spectra with normalization.
- Calibration with 10-point polynomial fit at system or single experiment level.
- Trimming of data file for regions of interest.
- Data compression depending upon the relative sampling and reaction rates.
- All processing functions also available on current data as it is still being acquired.
- Curve rotation for compensating modified baseline trend after reaction.
- ASCII file import / export for external compatibility.

Acquisition and Presentation Features

- Software linearisation for different thermo-couples.
- Sampling rate selectable to suit reaction timings.
- Multiple sampling option for noise reduction.
- Extensive spectrum display manipulations, e.g., scaling, scrolling, defining regions-of-interest, axis choice, etc. with twin-cursors based operation.
- Flexible plot-out for publications, reports, etc. Generates Time-plot and X-Y plot with features like linear or log scale, legends, footnote, axes markings and colour option.
- Real-time plot of live data and status display for monitoring the current run.
- A software module can be added for implementing any required control of the instrument.

The main user-interface is affected through 3 primary concurrent screens: off-line analysis screen for processing of an earlier experiment (Fig.2), on-line analysis screen for processing the on-going experiment (Fig.3), and acquisition screen (Fig.4) with real-time plot for monitoring the experiment in progress. The corresponding primary tasks in turn unfold a number of child windows for various processing and interactive functions. Multi-tasking permits concurrency of many functions. The software has been written for Windows-95/98 platform making extensive use of system calls (API) for improved performance.

The hardware in the present version has been implemented utilizing industrial grade modules housed as a stand-alone unit. A different scheme of hardware can be easily accommodated by the data acquisition modules of the software if required, for example, for acquiring faster reactions, a configuration internal to PC, special analog signal handling etc. The electronics can accommodate a large span of input ranges (above 10 mV full scale in the present version), with or without linearisation for thermocouple characteristics.

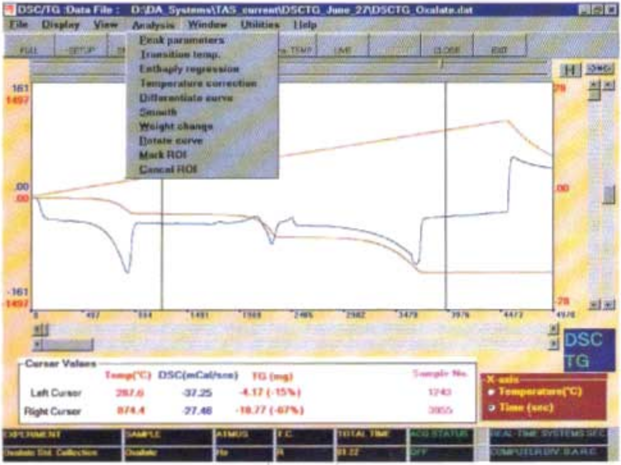

Fig. 2 Data analysis screen

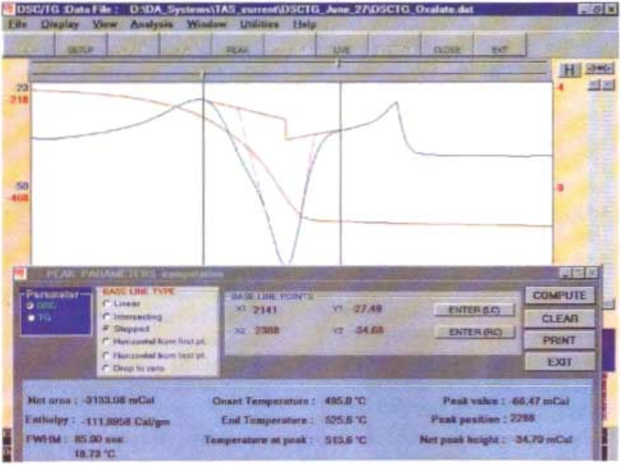

Fig. 3 Peak evaluation window

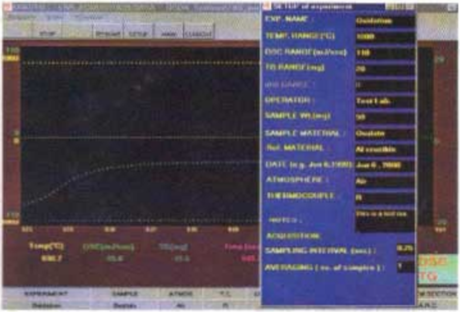

Fig.4. Acquisition screen

Implementations

The data stations have been implemented in 7 different configurations: 3 for simultaneous DTA/TG, TG/DSC and TMA/TG analyses, and 4 for single-parameter modes of DTA, DSC, TMA or TG. Each installation requires individual customisation for compatibility with the parent instrument.

In addition to data acquisition and processing, a control element can also be incorporated into the system, if required, for any instrument-specific control functions. This can be very useful for instruments that have the required provision and need computerization, specially for any apparatus developed indigenously *ab initio*.

Application Areas

The development of these data stations has a wide domain of application. Thermo-analytical techniques of DTA, DSC, TG, TMA have been used extensively in diverse areas of chemical and metallurgical engineering, chemistry, materials science, foods and pharmaceuticals. They are used as tools for quality assurance, process and product development, as well as basic research in these fields.

In the field of atomic energy also they have found many applications. Some examples are: in nuclear fuel cycle for chemical quality control and high temperature refractory materials development for fuel fabrication, reactor safety analysis with fuel's behavior in normal, transient and accident conditions, post-irradiation diagnostics of fuel from plants, thermodynamic stability analysis of the system involving fuel, fission products, clad components and coolant, characterization of glass matrix for vitrification of high level nuclear waste, evaluation of packaging materials for radiation sterilization (in ISOMED facility), etc.

Industrial application areas include extraction and refinement of metals, alloy designing, development of inorganic materials like ceramics, minerals and glasses, design of polymers for industrial and space applications, fuel analysis in coal and oil-based power plants, finger-printing of products, properties and composition evaluation in pharmaceutical, bio-technology and food industry, etc.

PRECISION ALIGNMENT OF MIRRORS OF GAMMA RAY TELESCOPE AT MT. ABU

R.L.Suthar,
Central Workshops

Introduction

Central Workshops (CWS), BARC, has carried out, during April 2000, a very precise alignment of 34 numbers of 600 mm diameter glass mirrors of two of the three Vertex Elements of the "TACTIC" Gamma Ray Telescope facility installed at Mt. Abu site of Nuclear Research Laboratory (NRL), BARC. For this purpose, a Laser based Plumb Line (LPL) was earlier designed and developed by CWS and successfully used for alignment of the mirrors of the Imaging Element of the Telescope. "TACTIC" facility consists of an Imaging Element (Central Telescope) and three Vertex Elements (Detector Units), located on the vertices of an equilateral triangle of 20 metre sides. This facility aims for detailed investigations on interesting astrophysical objects, using a recently opened field of Gamma Ray Astronomy and Astro-physics and thereby would be making fundamental contributions to our understanding of the universe. The Imaging unit is at the centre of three Vertex units. The reflector of the telescope covers an area of 4 metre x 4 metre (Fig. 1(a)). Weight of the individual mirrors, of 4000 mm focal length, varies from 20 kg (24 mm thick) to 32 kg (38 mm thick).

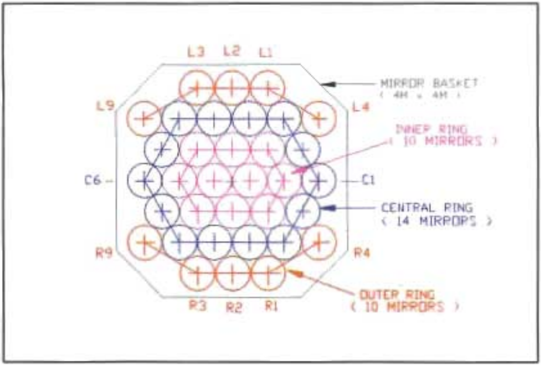

Fig.1 (a) Location of 34 numbers of mirrors of Gamma Ray Telescope

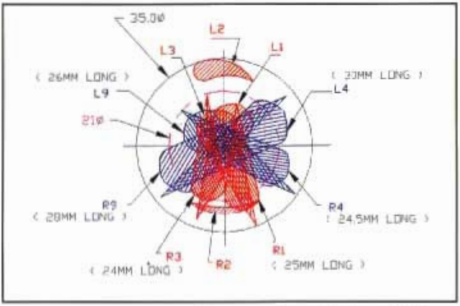

Fig. 1 (b) Enlarged view of images as obtained in January 1998

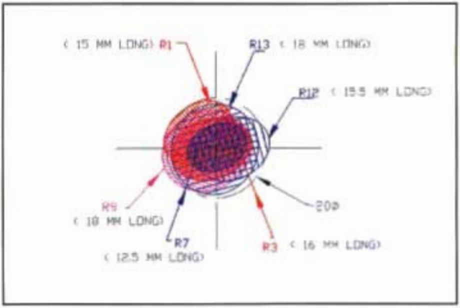

Fig. 2 (a) Enlarged view of expected images (April 2000)

Previous Work

The Focal Spot size (containing the images formed by 34 mirrors) obtained in January 1998, for the Imaging Element, was within 35 mm diameter (Fig 1(b)). Even this reduced size was obtained after several attempts were made (in the Ist phase) by positioning / re-positioning the Focal plane at an optimum distance from the spherical concave surface of the mirrors. All the 34 mirrors are having almost identical focal length of 4000 mm (± 30mm). NRL desired that the Focal Spot size be reduced even further to about 21mm diameter, so as to improve the resolution of the Telescope. The accuracy of the LPL and the procedure for its use was such that the image from a specific mirror could be positioned within ± 1 mm of the desired point on the Focal plane, at a distance of 3850mm form the surface of the mirrors.

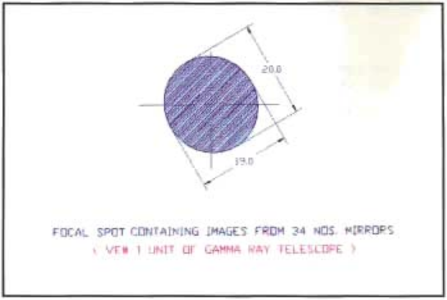

Fig. 2 (b) Enlarged view of obtained Focal Spot (April 2000)

Current Work

CWS later carried out (IInd phase) modifications by re-positioning the individual "problematic" mirrors (mirrors producing unacceptably longer images) closer to the Focal plane. The extent of changes/ optimum distances for specific mirrors, to obtain a minimum possible size of Focal Spot, were theoretically established. Based on such studies, it was felt that Focal Spot size could be reduced practically to a size of 20 mm (Fig 2(a)). Actual modifications (of re-positioning of mirrors) have been implemented in January/ February 2000. Efforts were made to contain the Focal Spot size to within 20 mm diameter during the process of alignment work of the mirrors, during April 2000. The Focal Spot size obtained now is within 20 mm diameter (Fig. 2(b)).

Fig.3 shows the overall size of one of the Vertex Elements of the Telescope. It is being made ready for the mirror alignment work. A person, sitting (at Focal plane level) on the camera holding plate, reads the position of the Laser beam reflected by a specific point on the individual mirror. The mirror is accordingly tilted so as to meet the targeted requirements of alignment and then clamped in that position. The alignment work had to be carried out

Fig. 3 Vertex Element of the Telescope

in bright light conditions, during the day time only, to restrict the "as visible" size of the Laser beam, as received at the Focal plane, to within 4 mm. During the evening hours, the work had to be stopped, due to increase in the "as visible" size of the divergent Laser beam, because of reduced intensity of the background light.

Fig. 4 Alignment work in progress

Fig. 4 shows the Laser based Plumb Line (LPL) positioned on the mirror being aligned. The Focal plane has a circular target (concentric circles of 4 mm to 160 mm in diameter).

Fig. 5 shows the close-up of the LPL and the mirror which reflects the oncoming Laser beam to the circular target on the Focal plane.

Fig. 6 shows the close-up of side view of all the 34 mirrors. The continuity of the curved reflection of the straight beam (Tie Rod fixed in front of the mirrors) shows the accuracy of the overall semi-paraboloid reflecting surface of the telescope.

Fig. 5 Laser based Plumb Line positioned over a mirror

Fig. 6 Side view of mirrors after alignment

Fig. 7 shows the front view of the mirrors and the circular target fixed in the Focal plane.

Fig. 7 Front view of mirrors after alignment

Conclusion

The achievement of reduced (and optimum possible) Focal Spot size will lead to an appreciable improvement in the resolution of the Telescope. Pixel size of the camera of the Telescope, containing the PMTs (Photo Multiplier Tubes), is 21 mm in diameter. In the present limitation of mirrors having almost identical 4000 mm Focal length, the theoretically optimum Focal Spot size could only be 19mm in diameter. CWS has been successful in meeting the targeted requirements.

ANUP-16 SUPER COMPUTER INSTALLED AT AERONAUTICAL DEVELOPMENT AGENCY, BANGALORE

A parallel super computer ANUPAM-Pentium/16, based on the latest super computing technology developed at Computer Division, BARC, was installed at Aeronautical Development Agency (ADA), Bangalore, on Monday, June 1, 2000. The system will be used for the solution of very large Computational Fluid Dynamics (CFD) problems related to the design of aircrafts. ANUPAM system is 5 times faster than the existing PACE-32 super computer at ADA, supplied by ANURAG, Hyderabad, a few years back. The total cost of the ANUPAM super computer is Rs. 30 lakhs which is quite low as compared to the cost of Rs. 2 crores for the PACE- 32.

The ANUPAM super computer, christened by ADA as ANUP-16, was inaugurated by Prof. S. M. Deshpande, Convener, CFD Center, Indian Institute of Science (IISc), Bangalore. The inaugural function held at ADA-CFD Lab was well attended by many senior scientists involved in CFD computations, from ADA, IISc, HAL, ISRO, GTRE and ADE.

The installation of 16-node ANUPAM at ADA is a very significant achievement. ADA's interaction with BARC started in 1994, when a very large 3-D CFD problem related to bifurcated air-intake ducts of LCA was solved on a 16 node ANUPAM-860 super computer developed earlier by BARC. This problem could not have been solved anywhere else as it was taking more than 30 days of computational time for a single result on the other computers available at that time. ADA has been primarily using PACE-32 super computer for the last 4 years for meeting their high speed computational requirements. ADA decided to procure Pentium PC based ANUPAM super computer from BARC, as this was found to be much faster and highly cost effective system in a recent benchmarking exercise by its scientists. ADA, for the first time, could run a CFD problem involving 4 million grid points on BARC super computer which could not be even loaded on any other system in the country.

AIRCRAFT ENGINE DUCT DESIGN

The ANUPAM-16 has distributed memory MIMD architecture with 16 nodes and a file server. Each node has a Pentium-III @ 550 MHz, with 256 MB memory and 16 GB hard disk. The file server is Pentium-III @ 550 MHz, with 512 MB main memory and 40 GB hard disk. The nodes and file server are interconnected by a Fast Ethernet switch of 100 Mbps speed. The parallel software consists of ANULIB, the message passing library of BARC and standard interfaces like MPI and PVM. The system is supported by parallel processing tools : ANULIB to MPI converter, parallel system simulator PSIM, syntax checker for ANULIB programs SYN, static flow analyzer for FORTRAN programs FFLOW and a recently developed Hold utility for putting any parallel/sequential job running on the system on hold for giving priority to the production runs.

ANUPAM series of systems, currently available from BARC, are based on either Pentium PCs or Alpha work stations and can be easily integrated up to 128 nodes, thus giving a sustained speed up to 25 Giga flops on ANUPAM-Pentium and 50 Giga Flops on ANUPAM-Alpha super computers. The systems are designed using industry standard, readily available hardware and software components and directly marketed by BARC through its Technology Transfer & Collaboration Division. Even though the full systems can be supplied by BARC, most of the components can be procured directly from the market by the organization interested in having the system, as the systems are based on industry standard components. BARC can provide the necessary assistance in integrating the system on site. This mode of integrating system at site is preferred, as it is more cost effective and requires much less effort in integrating the system.

In the case of ADA, most of the major components of ANUPAM were procured directly from the market, under the advice of Computer Division, BARC. Three experts from BARC took less than a week to complete the integration of the parallel system at site after the basic hardware and software components were procured and installed by ADA.

While PACE-32 is having a sustained speed of 1 Giga Flops, the sustained speed of ANUP-16 is about 5 Giga Flops.

ANUP-16 System Details

File Server	Pentium III 550 MHz, 512 KB cache, 512 MB main memory, 40 GB HDD
Node Processor	Pentium III 550 MHz, 512 KB cache, 256 MB main memory, 16 GB HDD
Communication	100 Mbps Fast Ethernet switch with 90 Mbps sustained speed
Architecture	Loosely coupled distributed memory MIMD, cluster-based
Operating System	Red Hat Linux 6.1
Compilers	Absoft Fortran 77 and Fortran 90, gcc
Parallel Software	ANULIB, MPI, PVM
Parallel Software Tools	ANULIB to MPI converter, SYN, PRE, Hold, FFLOW

Benchmark Results on ANUP-16

CDE VASBI-2	ANUP-16 Time for 1 iteration	PACE-32 Time for 1 iteration	Ratio
Fine Grid	22.16 sec	108.71 sec	4.91
Medium Grid	6.77 sec	27.42 sec	4.05
Coarse Grid	1.21 sec	6.56 sec	5.42

SYMPOSIUM ON BIOMEDICAL ENGINEERING AND NUCLEAR MEDICINE

A Symposium on Biomedical Engineering and Nuclear Medicine (SBME-NM 2000) was held at the Training School Hostel, BARC, during January 27 to 29, 2000. It was attended by more than 250 delegates from all over the country including around a hundred engineering students.

It was preceded by a two-day workshop on Medical Imaging conducted on 24th and 25th of January, 2000. More than 100 participants from all over the country participated in this workshop. The workshop was focussed on Medical Imaging techniques like CT, MRI, Ultrasound, Scintigraphy and PET, and covered theroretical as well as practical aspects. In her inaugural address of the workshop, Dr (Ms) A.M. Samuel, Director, Biomedical Group, BARC, defined Biomedical Engineering as the "Quantification or measurement of biological parameters in the field of medicine for better health care of the mankind," and stressed upon the need for improving the status of Biomedical Engineering in the country.

In the inaugural session of the symposium, Dr S.K. Kataria, Head, Electronics Division, BARC and Chairman of the Symposium Organising Committee, welcomed all the delegates.

Dr S.S. Kapoor, Director, Physics and Electronics & Instrumentation Groups, BARC and Chairman of the Advisory Committee, SBME-NM 2000, delivered the presidential address. He stressed upon the need for organising such symposia more frequently in order to increase interactions among the experts from various disciplines and contribute for the rapid growth of this field in our country. He appraised the delegates of the latest developments in the field like, combining of MRI and PET images for the study of structure as well as the function of internal organs of the body.

Dr Anil Kakodkar, Director, BARC, inaugurating the Symposium on Biomedical Engineering and Nuclear Medicine. Others in the picture (from left to right) : Dr S.K. Kataria, Dr S.S. Kapoor, Dr (Ms) A.M. Samuel and Dr G.D. Jindal

The symposium was formally inaugurated by Dr Anil Kakodkar, Director, BARC. In his inaugural address, he stressed upon the need to revive our ancient sciences and vast ocean of the knowledge by introducing objective measurements for the benefit of mankind. To give an example, he narrated the incidence of Nadi Pariksha performed on him by an Ayurvedacharya, and the finer observations given by the latter were practically true. He urged the Biomedical engineers and scientists to make use of all the advances in computers, artificial intelligence, microelectronics and miniaturized sensors to translate the ancient knowledge into the language of modern science. The inaugural address was followed by the keynote address given by Dr (Ms) A.M. Samuel, Director, Biomedical Group, BARC and Co-chairperson of Advisory Committee of SMBE-NM 2000. She briefed the progress made in the field of Biomedical Engineering and Nuclear Medicine in the past century and highlighted the areas to be attended to immediately in the present century. Towards the end of the session, Dr G.D. Jindal, Convenor, SBME-NM 2000, presented a vote of thanks.

Dr Anil Kakodkar also formally inaugurated an exhibition of the products related to the field of Biomedical Engineering, which was arranged at the venue of the symposium. Over twenty big and small companies exhibited their products. As a first step towards Nadi Pariksha, based on the analysis of variabilities of peripheral blood flow, a PC-based instrument called Medical Analyzer demonstrated a low cost solution for electro diagnostic laboratory.

WORKSHOP-CUM-ACCREDITATION COURSE FOR HOSPITAL RADIO-PHARMACISTS

A workshop-cum-accreditation course was organised by Board of Radiation & Isotope Technology (BRIT) under the auspices of Board of Research in Nuclear Sciences (BRNS) and Radiopharmaceuticals Committee (RPC) at Kasturba Medical College (KMC), Manipal, Karnataka, during March 6-10, 2000, with Dr Diwakar Prasad, Senior Manager, QA/GMP and Secretary, RPC, as convenor.

Widespread use of Technetium-99m radio-pharmaceuticals for diagnostic investigations demand that safe and efficacious radiopharmaceuticals are formulated at the Hospital Radiopharmacy (HRPh) using generator systems and kits. In India, MEK-based solvent extraction generator system involving open wet radiochemical operations is widely used. This necessitates strict compliance of both pharmaceutical and radiological safety measures in hospital radiopharmacy practices. It is in this context that Accreditation/ Certification Programme for the working science graduate technologists has been initiated to help the proper practice of hospital radiopharmacies to conform to Good Hospital Radiopharmacy Practices (GHRP). The present course, the fourth and the final in the series planned earlier, was conducted in collaboration with the Nuclear Medicine Department of KMC, Manipal.

Dr M.S. Valiathan, Ex-Vice Chancellor, MAHE, releasing the course manual of the workshop at the inaugural function.

The workshop was inaugurated by the renowned cardiac surgeon, Dr M.S. Valiathan, former Vice-Chancellor, Manipal Academy of Higher Education (MAHE). A Course Manual entitled "Radiopharmaceuticals and Hospital Radiopharmacy Practices", compiled and edited by Dr N. Ramamoorthy, Mr V. Shivarudrappa and Dr (Ms) Amita A. Bhelose, was released on this occasion. The Chief Guest, in his address, mentioned that there is a rapid growth in medical technology during the past 50 years and stressed the need to keep update with new developments.

Dr N. Ramamoorthy, Head, Radiopharmaceuticals Division, BARC and Dy. Chief Executive, Radiopharmaceuticals & Labelled Compounds (RPLC), BRIT, in his remarks, stressed the importance of appropriate exposure on safety and efficacy aspects needed for the graduate technologists already working in the field and the useful role of the current workshop in this regard.

Seventeen participants and seven observers attended the course. The workshop consisted of two Guest lectures, one each by Dr N. Ramamoorthy, Head, RPhD, BARC, on "Trends in Diagnostic and Therapeutic Radiopharmaceuticals," and by Dr O.P.D. Noronha, Head, RMC, BARC, on "The Practice of Hospital Based Radiopharmacy at the RMC - Past, Present and Future", and 10 main course lectures and 3 practical demonstrations. The faculty consisted of seven scientists from BRIT, one from Radiological Physics & Advisory Division (RPAD), BARC, and two from KMC, Manipal. The topics of lectures were designed to include all the relevant subjects in the regular practice of hospital radiopharmacy, while the demonstration practicals emphasised the importance of GHRP during the preparation/ formulation and quality control testing of radiopharmaceuticals at the hospital radiopharmacy. An assessment test was conducted at the end of the programme and the successful participants were awarded the certificates.

The workshop concluded with a valedictory function presided over by Dr P.L.N. Rao, Dean, Kasturba Medical College, Manipal. The valedictory address was given by Dr O.P.D. Noronha, Head, Radiation Medicine Centre (RMC), BARC, who also distributed certificates to successful participants.

TWELFTH NATIONAL SYMPOSIUM AND WORKSHOP ON THERMAL ANALYSIS (THERMANS-2000)

Twelfth National Symposium and Workshop on Thermal Analysis (THERMANS-2000) was jointly organised by Indian Thermal Analysis Society (ITAS), c/o Analytical Chemistry Division, BARC, and Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur, during March 26-29, 2000 at the Department of Chemistry, DDU Gorakhpur Unversity, Gorakhpur.

Inauguration of 12th National Symposium on Thermal Analysis (THERMANS-2000) at DDU Gorakhpur University

The symposium was held during March 26-27, 2000 while the workshop was arranged during March 28-29, 2000. Over 140 delegates attended the symposium while the workshop was attended by 50 participants from various universities. Several delegates from various scientific and academic organisations like BARC, Indira Gandhi Centre for Atomic Research (IGCAR), Vikram Sarabhai Space Centre (VSSC), Defence Laboratories and Universities participated in the symposium. 91 scientific papers on various aspects of thermal analysis like the study of inorganic complexes, polymers, explosives, nuclear materials, cements, ceramics, glasses and other materials were presented. Invited lectures were delivered by experts from various academic institutions.

The workshop on thermal analysis dealt with lectures on basic aspects of different thermoanalytical techniques like Thermogravimetry Analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC) and other complementary techniques and the applications of these techniques in materials research, cement industries and for nuclear waste management. A preprint volume consisting of contributed papers and invited talks for the symposium was brought out by ITAS and was distributed to all the delegates. The workshop participants were provided with a technical document consisting of lectures delivered at the workshop also. The symposium was supported by Board of Research in Nuclear Sciences, Atomic Energy Regulatory Board, and Council for Scientific and Industrial Research. Several scientists from BARC served as members of organising committee, while Prof. N.B. Singh served as the chairman of the local organising committee.

TRAINING UNDER IAEA FELLOWSHIP PROGRAMME

BARC imparts training to a large number of IAEA Fellows in wide-ranging areas of nuclear science and technology. On March 31, 2000, two IAEA fellows from Ethiopia, Mr Dawit Demeke and Mr Tariku Wordofa, completed their three-months training in Nuclear Medicine Techniques from the Radiation Medicine Centre (RMC) of BARC. After

Mr Dawit Demeke and Mr Tariku Wordofa, the two IAEA Fellows from Ethiopia, after receiving the Certificates from Mr A.K. Anand, Director, Technical Coordination and International Relationships Group, BARC.

successful completion of their training, Mr A.K. Anand, Director, Technical Coordination and International Relations Group, BARC, presented Certificates to the Fellows. The RMC is a WHO-recognized collaborating centre in the field of nuclear medicine and is an active participant in the development programmes sponsored by the IAEA. Till date, RMC has trained about 70 IAEA Fellows in various aspects of nuclear medicine.

FORTHCOMING SYMPOSIUM

Meenakshi College for Women and Forum d' Analystes, Chennai, is organising an "International Conference on Analysis and its Applications" for 4 days in December 2000 under the auspices of Board of Research in Nuclear Sciences (BRNS).

The conference is intended to gather leading workers in different aspects of analysis - real, complex, abstract, fuzzy, non-standard, etc., and provide them interaction with leading international experts in these fields. As the publishing organization of the International periodical *The Journal of Analysis* emanating from India, Forum d' Analystes feels that it is its responsibility to provide a platform to beginners in the discipline of mathematical analysis to get exposed to significant work done by international experts in this discipline together with applications thereof.

(Contact : Ms. K.S. Lakshmi, Principal, Meenakshi College for Women, Arcot Road, Kodambakkam, Chennai 600 024, Tamil Nadu.)

BARC SCIENTISTS HONOURED

■ Ms Prajakta Varadkar, a Ph.D student under the DAE-Mumbai University Collaboration Scheme and working in the Radiation Biology Division since December 1998, has been awarded the Dr A.R. Gopal-Ayengar Radiobiology 2000 best poster award for her paper entitled "Response of signaling pathway following whole body gamma-irradiation of mice", at the International Conference on Radiation Biology - Radiobiology 2000" held at Trivandrum during February 17-19, 2000.

This award, given biennially, carries a prize money of Rs. 1000/- in cash and a citation.

■ The following scientists were awarded the THERMANS-2000 awards at the "12th National Symposium and Workshop on Thermal Analysis", held at the Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur, during March 26-29, 2000.

• Mr R.K. Mishra, Waste Management Facilities, BARC, Tarapur, was awarded prize for best presentation in Inorganic Chemistry Section for his paper entitled, "A study of solid state reaction between strontium carbonate and ruthenium dioxide" by R.K. Mishra, J.G. Shah, R.G. Yeotikar and S.R. Dharwadkar.

• Ms Monideepa Ali of Applied Chemistry Division, BARC, was awarded best oral paper award in Physical Chemistry Section for her paper, "Preparation characterization and thermal stability of Cs_2ZrO_3" by M. Ali, R. Mishra, S.R. Bharadwaj, A.S. Kerkar, S.C. Kumar and D. Das.

• Ms Meera Keskar of Fuel Chemistry Division, BARC, was awarded second best poster presentation award for her paper, "Preparation and thermal studies on $Pu(MoO_4)_2$ and $Na_2Pu(MoO_4)_3$" by N.D. Dahale, Meera Keskar, K.D. Singh Mudher, R. Prasad and V. Venugopal.

The above awards were instituted by TA Instruments Inc. USA for best presentation in the oral session by young scientists below the age of 30 and for best poster presentations.

■ Dr V. Venugopal, Head, Fuel Chemistry Division, BARC, was awarded the prestigious Netzsch-ITAS Award for his outstanding contributions on the application of thermal analysis for nuclear materials. The award carries a citation and a cash award of Rs 7,500/-. He was presented the award at the Twelfth National Symposium and Workshop on Thermal Analysis held at Gorakhpur during March 26-29, 2000. The Award is instituted by Netzsch Geratebau GmbH, Germany, in collaboration with Indian Thermal Analysis Society and is awarded to a senior scientist above the age of 40 for his outstanding contribution to thermal analysis.

STATUS OF WORLD NUCLEAR POWER GENERATION

Statistics issued by the Power Reactor Information System (PRIS) of the International Atomic Energy Agency indicate that 436 nuclear power plants around the world produced a total of 2394.6 TWh of electricity in 1999, compared with 2291.4 TWh from 434 plants in 1998.

During 1999, four new nuclear power plants - with a total net capacity of 2700 MWe - were connected to national grids for the first time, one each in France, India, South Korea, and the Slovak Republic. Construction work started on seven new nuclear power plants - one in China, two in Taiwan, two in Japan, and two in South Korea. This brings the total of plants designated as "under construction" around the world to 38. The total below is based on the PRIS statistics. It shows the present situation in 32 countries operating nuclear power plants.

NUCLEAR POWER REACTORS IN OPERATION AND UNDER CONSTRUCTION AT THE END OF 1999

Country	Reactors in operation		Reactors under construction		Nuclear electricity supplied in 1999	
	No of Units	Total MW(e)	No of Units	Total MW(e)	TWh(e)	% of Total
Argentina	2	935	1	692	6.6	9.0
Armenia	1	376			2.1	36.4
Belgium	7	5712			46.6	57.7
Brazil	1	626	1	1229	4.0	1.3
Bulgaria	6	3538			14.5	47.1
Canada	14	9998			70.4	12.7
China	3	2167	7	5420	14.1	1.2
Czech Rep.	4	1648	2	1824	13.4	20.8
Finland	4	2655			22.1	33.1
France	59	63103			375.0	75.0
Germany	20	22282			160.4	31.2
Hungary	4	1729			14.1	38.3
India	11	1887	3	606	11.5	2.7
Iran			2	2111		
Japan	53	43691	4	4515	306.9	36.0
Lithuania	2	2370			9.9	73.1
Mexico	2	1308			9.6	5.0
Netherlands	1	449			3.4	4.0
Pakistan	1	125	1	300	0.7	1.2
Romania	1	650	1	650	4.8	10.7
Russia	29	19843	4	3375	110.9	14.4
South Africa	2	1842			13.5	7.4
South Korea	16	12990	4	3820	97.8	42.8
Slovak Rep.	6	2408	2	776	13.1	47.0
Slovenia	1	632			4.5	36.2
Spain	9	7470			56.5	30.1
Sweden	11	9432			70.1	46.8
Switzerland	5	3079			23.5	36.0
Taiwan	6	4884	2	2600	36.9	25.3
UK	35	12968			91.2	28.9
Ukraine	16	13765	4	3800	67.4	43.8
USA	104	97145			719.4	19.5
Totals	**436**	**351718**	**38**	**31718**	**2394.6**	

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