From the Director's Desk....

I am happy to see that the first issue of this year's RRCAT Newsletter is ready to go to press. The issue reports on a number of significant advances made in the Centre over the last few months.

The Centre reached a major milestone on December 6, 2011 when Indus-2 was operated at 100 mA current at the design energy of 2.5 GeV. This could be accomplished due to another outstanding achievement of in-house development of new technology of solid state RF amplifiers, which enabled replacement of two failed klystrons in the Indus-2 RF power system with high power solid state amplifiers. Starting with development of an amplifier module of 320 W output power and using it as a building block, two high power solid state RF amplifiers operating at Indus-2 frequency of 505.8 MHz were built within one year providing output power of 20 kW and 30 kW. This also required in-house development of several other RF components like power dividers/combiners, variable phase shifters, low and high power directional couplers, RF dummy loads etc. The above two units were integrated with the Indus-2 RF system with resultant enhancement of Indus-2 operation to 2.5 GeV energy. The total output power of solid state RF amplifiers has subsequently been increased to 100 kW. It is for the first time that high power solid state amplifiers operating at high frequency (>500 MHz) have been developed and successfully deployed in a synchrotron radiation source, anywhere in the world. This capability generation is also an important step towards achieving self-reliance in the strategic area of RF power generation envisaging use of solid state amplifiers in place of klystrons for building high energy proton accelerators in the future.

The development of beamlines on Indus-2 and utilization of commissioned beamlines are also making fast progress. Both the Synchrotron Radiation Sources, Indus-1 and Indus-2, have been operating in the round-the-clock mode : Indus-1 at 450 MeV energy, 100 mA current, and Indus-2 at 2.0 GeV energy, 100 mA current. At present, five beamlines are operational on Indus-1 and six beamlines on Indus-2. These are offered to researchers from academic institutions, universities and national laboratories. Several studies have been carried out using these beamlines and results have been published in international journals. Two more beamlines on Indus-2 are nearing final commissioning and eight others are at different stages of development. It is also planned to add five insertion devices in the straight sections of Indus-2 ring and to build beamlines on them during the 12th Plan. In order to enhance the utilization of Indus synchrotrons a series of interaction meetings have been started and first three meetings have already been organized which have resulted in considerable interest among potential users.

Superconducting RF cavities are essential elements for building high intensity proton accelerators required for the Department's long-term programmes on spallation neutron source and accelerator-driven sub-critical systems. The first two single-cell 1.3 GHz superconducting RF cavities developed under Indian Institutions-Fermilab Collaboration programme had provided acceleration gradient of 21 MV/m with $Q > 10^{10}$ at 2K. In a continuation of this activity we have now successfully developed two more single-cell 1.3 GHz niobium cavities with improved performance of acceleration gradient of 37.5 MV/m with $Q > 10^{10}$ at 2K. Next, a new technique of superconducting RF cavity fabrication based on laser welding has been demonstrated. As compared to established technique of electron beam welding, laser welding offers advantages of low energy deposition (less shrinkage and distortion in the job), vacuum-less welding and much lower capital cost.

There have been significant accomplishments in laser-related activities as well. A few notable advancements showing high quality of research, development and applications include demonstration of soft x-ray lasing at 46.9 nm in a capillary discharge argon plasma, development of cw and mode-locked fiber lasers, development of nuclear fuel pellet inspection system jointly with Nuclear Fuel Complex for their fuel fabrication facility, random lasing in ZnO nano-particles, investigations on photodynamic action of silica nano-particles on breast and oral cancer cell lines, laser rapid manufacturing of porous metallic structures for engineering applications, development of narrow line-width tunable radiation source based on second harmonic of copper vapour laser pumped dye laser and optical twisters-driven multi-layered micro-motors for flow control inside micro-fluidic channels.

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Some of the above noteworthy advancements are briefly described as news items in the present issue. The newsletter also carries theme articles presenting a comprehensive description of some R&D activities which have acquired a significant level of maturity with resultant applications. The three theme articles included in this issue are on development of non-destructive type fast current transformers which are used as diagnostic instruments in accelerators, optical coherence tomography for non-invasive depth-resolved three-dimensional imaging of biological tissues with micrometer scale resolution, and a newly identified family of resonant convertors which have myriads of potential applications in power supplies for accelerators as well as lasers.

In the end, I appreciate the Editorial Board for their commendable efforts in presenting a nice spectrum of activities and accomplishments of the Centre, and in bringing out the Newsletter well in time.

With best wishes

March 14, 2012

P. D Gupta

(P D Gupta)
Director

From the Editor's Desk....

We feel happy to bring out the first issue of the RRCAT Newsletter of the year 2012 well in time. It presents a large number of reports on the various research and development activities, that have taken place in the Centre during the later half of the past year, in areas covering lasers, accelerators, and related advanced technologies.

Since the launch of the last issue, the Centre has marched ahead with several new developments. Most notable of these is surely the successful operation of Indus-2 at 2.5 GeV beam energy and at 100mA beam current, which by itself is a significant milestone in the country's accelerator programme. The first of the reports in the Newsletter documents this important achievement. Following this is a series of reports which narrate the different key components that were developed and incorporated for making Indus-2 operate at 2.5 GeV energy and also depicts the different studies that were carried out using various facilities created around Indus-2. The other important developments which are worth mentioning include development of 1.3 GHz single cell SCRF cavities with improved performance, hydrogen ion beam extraction from ECR ion source and beam characteriztaion, breamsstrahlung source term measurement for 450 MeV electrons, buffered chemical polishing of niobium half cells. Reports of other significant research and developments include studies of spin wave instabilities in ferrite and garnets for CW ferrite circulators, studies on scattered radiation dose at SR beam line hutches of Indus-2, electron beam irradiation using accelerators among others.

The Laser part of the Newsletter contains a range of reports spanning the different aspects of research and developments in the area of lasers. These include demonstration of soft X-ray lasing achieved in capillary discharge plasmas, development of optical twisters-driven multilayered micromotors, development of narrow line-width tunable radiation source based on second harmonic of CVL pumped dye laser, laser rapid manufacturing of porous structures for engineering applications, development of PHWR nuclear fuel pellets inspection system for NFC fuel fabrication facility and measurement of absolute diffraction efficiency of a variable line spaced grating using Indus-1 reflectivity beamline among others. The infrastructure section highlights reports on the accomplishments by our computer, library and civil wings. The publication section consolidates the scientific achievements and the news section provides coverage on the various happenings the Centre has witnessed over the last few months. This is followed by three theme articles, which focus on three important areas of research activities viz. development of non-destructive type fast current transformers (FCTs) and monitors for accelerators at RRCAT, optical coherence tomography for tissue diagnosis and the third on resonant immittance converters and their applications in power supplies for accelerator and laser subsystems under the Young Scientist Forum.

It is our privilege to put together all these expositions. We wish to express our deepest gratitude to the Director, RRCAT for his encouragement and active support at various stages in bringing out the present issue.

March 14, 2012

S K Majumder

S K Majumder
Chief Editor