International accelerator facility of beams of ions and anti-protons*

The focus of the workshop held under the auspices of the Indo-German bilateral exchange programme of DST and BMBF. was to explore possible Indian participation in the new international facility envisaged by GSI, Darmstadt. About 45 researchers from various universities and institutes in India and 10 from Germany participated in the workshop. The objective of the workshop was two-fold: One was to acquaint Indian researchers with research possibilities with the proposed accelerator facility at GSI and the second was to introduce the German team to the current research and development in India based on accelerators. It was contemplated that this workshop could facilitate identification of possible areas of cooperation in physics, instrumentation and accelerator technologies, particularly with the new GSI Facility in mind, which is expected to open new research areas, due to its capability to provide beams of unprecedented intensity and quality with energies in the hitherto unexplored regions.

There were 10 presentations from the German side on the accelerator, instrumentation and research possibilities with the new facility envisaged by GSI in addition to some of the work being carried out at present. There were 10 presentations from the Indian side covering accelerators in India (in operation or under construction) and the research being done with them (see www.nsc.ernet.in/events/calendar/indogerman.html).

Currently GSI facilities consist of a linear accelerator for heavy ions (Unilac) capable of accelerating ions to an energy ≤ 15 MeV/A, injecting into a heavy ion synchrotron SIS that boost the energies to 2 GeV/A for $A/q = 2$. The heavy ions from the synchrotron SIS are used to produce radioactive nuclei through projectile fragmentation or can be stored and cooled in the experimental storage ring (ESR) to reduce the energy spread of the ion beams to a value of $dE/E < 1 \times 10^{-4}$. The radioactive fragments can also be stored in the ESR.

The central part of the planned new accelerator facility at GSI is a synchrotron complex consisting of two separate synchrotron accelerator rings with 100 and 200 Tm maximum magnetic rigidity. The goal of the first synchrotron ring ($B = 100$ Tm) is to achieve intense pulsed (10^{12} ions/pulse) uranium ($q = 28^{+}$) beams at 1 GeV/A and intense pulsed (2.5×10^{13}) proton beams at 29 GeV. For the high-intensity proton beams, needed for anti-proton production, an additional dedicated linac injecting into existing ring SIS18 is planned. The concept for the proposed new facility is based on experience and developments at accelerators in nuclear and high-energy physics worldwide, and it also builds on the unique specifications and novel techniques developed at the existing GSI facility. Beyond this, new concepts and schemes to be introduced at the new facility, such as rapidly cycling super-conducting magnets, will require extensive and thorough simulation, design, engineering and prototype work. This holds for various aspects of the synchrotrons as well as the storage rings. Parallel Multi-Beam Operation will be a hallmark of this facility, which will allow three simultaneous experiments to be conducted.

The high-energy heavy ion beams will be used to produce radioactive nuclear species far away from the stability line through fragmentation reaction process. A large fragment separator will be used to transport the exotic species to a secondary target as well as identify them by their mass and charge.

The high-energy high intensity proton beam will be used for production of anti-protons, which will then be stored in a cooler ring. The expected intensity of anti-protons stored in the ring is $\sim 10^{11}$, which is several orders of magnitude higher than that obtained elsewhere.

The bunch compression schemes for the cooled heavy ions in the proposed storage rings would allow for extremely high-density (10^{23-24}/cm^3) plasma to be reached in interactions with solid targets.

The specific research goals of the new GSI facility are:

- Investigations with beams of short-lived radioactive nuclei, addressing important questions concerning nuclei far from stability, areas of astrophysics and nucleosynthesis in supernovae and other stellar processes, and tests of fundamental symmetries.
- The study of hadronic matter at the sub-nuclear level with beams of anti-protons, in particular of the following two key aspects: confinement of quarks and the generation of the hadron masses, the latter being intimately connected to the spontaneous breaking of chiral symmetry, a fundamental property of strong interactions.
- The study of compressed, dense hadronic matter through nucleus–nucleus collisions at high energies.
- The study of bulk matter in the high-density plasma state, a state of matter of interest for inertial confinement fusion and various astrophysical settings.
- Studies of Quantum Electrodynamics (QED) of extremely strong (electromagnetic) field effects, and of ion–matter interactions.

Apart from these fundamental studies, cancer therapy with heavy ion beams has been pursued at GSI. The use of energetic heavy ions has the advantage of localized energy deposition with millimetre accuracy. So far 200 patients (about 3500 irradiations) have been treated with no side effects and no recurrence in treated volume. These studies and therapy will be continued with the new facility as well.

The German government has assured funding to about 75% of the cost and the remaining 25% is expected to be contributed by other interested countries, so as to make this a truly international facility. The estimated cost is Euro 675 millions and the planned time-frame is 8 years. The German team welcomed participation from India in all areas of research and development.

It was clear from the presentations that opportunities for research in hitherto inaccessible areas of research in a wide range of nuclear, particle, atomic physics, plasma and astrophysics will become

*A report on the Indo-German Workshop on International Accelerator Facility of Beams of Ions and Anti-protons at GSI, Darmstadt, Germany held during 15–16 March 2004 at Nuclear Science Centre, New Delhi.

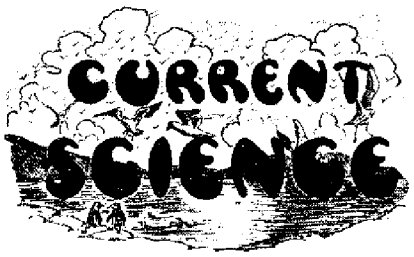
available at this facility. It is also an opportunity for Indian researchers to participate in front-line accelerator technologies and for manpower training.

Details of the future facility project are available at the GSI website: www.gsi.de

Any researcher in India, interested in contributing to or using the proposed research facility at GSI, should send a proposal immediately to Dr G. Padmanabham, International Division, Department of Science and Technology, New Delhi 110 016 (e-mail: gparc@alpha.nic.in) latest by 15 May 2004.

Amit Roy, Nuclear Science Centre, Aruna Asaf Ali Marg, New Delhi 110 067, India. e-mail: roy@nsc.res.in

FROM THE ARCHIVES



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Sri Jayachamarajendra Institute of Indian Medicine, Bangalore

On the occasion of the Laying of the Foundation Stone of Sri Jayachamarajendra Institute of Indian Medicine at Bangalore held on 11 December 1943, His Highness the Maharaja of Mysore declared:

'I have watched with interest the researches made in this country from time to time in the indigenous systems of medicine. For want of facilities or due to other circumstances, they do not seem to have been conducted on modern recognised lines. It is only exhaustive investigation based on scientific methods in a well-equipped laboratory that will help the achievement of definite results of permanent value.

The rapid spread of education and the introduction of the more scientific and systematic methods of allopathy have led to the neglect of our ancient Ayurvedic and Unani systems of medicine. No one can deny that many indigenous drugs and medicinal preparations are potent and valuable. But the days of blind belief in the authority of the written word are gone and any system of medicine must stand scrutiny by the searching eye of accurate observation and experiment. A careful and assiduous application of modern scientific methods of chemical and biochemical research into the actions and uses of our indigenous drugs can alone convince a thinking public. I am, therefore, glad to note that the aim and object of this Institution is not merely to train pupils in the art of preparing and modes of using the medicinal preparations for which Ayurveda and Unani are noted. It will be a centre for organized research, on modern scientific lines, into the actions and uses of our indigenous drugs and herbs.

The advent of allopathy has made it imperative to import from foreign countries large quantities of drugs and medicines, many of which are expensive. I hope that every attempt will be made, by diligent research in this Institution, to find out simple and inexpensive substitutes which will be within the reach of even the poorest class of patients.

It has been said that no two practitioners of Ayurvedic or Unani prepare their medicines according to the same formula. There is great scope for improvement in this respect; and the standardization of indigenous medicines may very well be another object deserving of consideration in this Institute.

I should like to see greater mutual understanding, a spirit of give and take, and more co-operation between the practitioners of indigenous systems and allopathy. After all, where a patient's ailment is concerned, it is his speedy recovery and restoration to good health that counts, and not the particular method of treatment adopted, and faith plays no small part in the process of healing. This Institution, I expect, will be a meeting place for all practitioners—indigenous and allopathic alike.'