Foreword

The past year saw several significant developments for the Laboratory. The largest impact certainly comes from the approval of the plans for a future international facility for beams of ions and antiprotons at GSI. The project was developed in close collaboration with the users and the international science community, and was reviewed in 2002 by the Wissenschaftsrat, the highest science advisory committee to the German federal government, which recommended realization of the project. Following this recommendation, the facility was subsequently approved for construction by the German government (February of this year), with two conditions: a staged construction schedule, and 25% international contribution to the cost of the project.

The prospect of realizing this challenging facility has triggered considerable activity, both at GSI and within the international science community. Working groups and proto-collaborations have formed in the major research areas and for accelerator construction. For a detailed discussion of concept, facility layout, and fields of research to be pursued at the future facility, the reader is referred to the 700 page Conceptual Design Report (http://www-new.gsi.de/zukunftsprojekt/index_e.html) and the documentation of a number of workshops since publication of the CDR, also posted on the GSI Website.

A second important development concerns the clinical ion beam facility for cancer treatment to be constructed at the Heidelberg University Hospital. Following the positive evaluation and recommendation for research support by the Wissenschaftsrat in 2001, the project underwent a final review in 2002 by the Deutsche Forschungsgemeinschaft (DFG), and the DFG Facility Commission approved the federal research-based contribution towards construction. This decision culminates the successful pilot project on ion beam therapy at GSI, where 170 patients have been treated so far. The clinical facility at Heidelberg is scheduled for commissioning in 2006, start of operation in 2007, and treatment, asymptotically, of 1000 patients per year.

While evaluation and successful approval of these projects was underway, the ongoing research program proceeded at full speed and with exciting results. Several unique studies were performed with beams of unstable nuclei (radioactive beams). For example, at the experimental storage ring ESR, the masses of neutron-rich fission product nuclei were measured for the first time with good mass resolution, using the time-of-flight mode. Masses for about 30 new nuclei could be measured in one experiment. Fission fragment nuclei were also successfully transported to the R3B reaction setup, where giant resonance excitation of the doubly-magic radioactive ^{132}Sn nucleus was measured. In light nuclei the excitation (resonance) spectrum of the very neutron-rich, particle-unstable hydrogen nucleus, ^{5}H, was determined in a fragmentation reaction of ^{6}He. Finally, the ground-state two-proton decay was observed for the first time in ^{45}Fe, concurrently with an experiment at GANIL. In nuclear astrophysics the fragmentation data of ^{8}B and the S-factor for the ^{7}Be(p, gamma) reaction at low energy were analyzed.

The HADES collaboration – addressing the study of di-leptons from the dense and hot reaction zone in high-energy nucleus-nucleus collisions – completed a successful production run for the carbon-on-carbon system, with the level-two (software) trigger pre-identifying Cerenkov rings being fully operational. The FOPI collaboration took data on doubly-strange cascade particles and on flow in asymmetric collision systems.

Interesting results were also obtained in other areas of research, ranging from precision measurements in atomic physics with cooled and stored beams to the fabrication and investigation of nanowires produced in nanopores from chemically etched ion tracks. Further investigations encompass direct spectroscopy of ions stopping in solids, electron-electron interactions and correlations in strong fields using highly-stripped, few-electron heavy atoms, and projectile ionization of low-charge state ions at high velocity, including also studies of the ionization probabilities of U^{28+} at SIS injection and acceleration energies, which yield important information on the vacuum conditions required at the planned future facility.

Major progress occurred in the development and construction of new equipment, e.g. for the ALICE TPC and TRD detectors. The highly appreciated delivery of components from the NOVA laser from Livermore gave a push to the PHELIX laser project where operation at 1 kJoule pulse energy is anticipated for the present year and petawatt operation for the end of 2004/beginning of 2005.

Considerable effort went into the R&D of superconducting magnets for the future project. Major advances in reducing the power losses in the Dubna Nuclotron type model magnets, and in increasing the ramp rate of a model magnet based on the RHIC magnet configuration at Brookhaven were achieved, reflecting very successful collaborations with these and other associated laboratories. Studies of beam lifetimes of low charge-state ions and of the vacuum performance of the SIS18 synchrotron in the presence of high current ion beams were carried out, providing important information on critical research and development needed in these areas.

These are just a few examples of a much broader range of activities described in the present Report. This Report, as in previous years, provides brief summaries of a broad spectrum of science activities and technical research and development projects at GSI. It also lists publication activities and presentations at seminars, conferences etc. of this work. The descriptions are kept at the technical level, in order to provide direct and prompt information to the science communities involved in the same research areas as those pursued at GSI.

For presentations and overviews of recent developments at GSI to a broader readership, including the science agencies and the general public, GSI is publishing in parallel regular news reports (GSI Nachrichten). Beyond that we are now also considering to publish regularly a more general report presenting an institutional and programmatic summary at a non-technical level.

It was again the enthusiasm and dedication of both, the GSI staff and the user communities, which produced this wide spectrum of exciting results in the research programs and provided the basis for the very successful developments of the various new projects including, in particular, the future international facility at GSI for ions and antiprotons. This is an appropriate opportunity to express GSI's special thanks to everyone involved!