# Foreword

This document gives the detailed yearly status report of the research activities at GSI. But the situation is perhaps somewhat different for 2001, in that a major activity that took place during the year is not explicitly described here. This is the preparation of the conceptual design report (CDR) for the future GSI facility, which was prepared last year with the help of the international science community. The work resulted in a 700-page report, 'An International Accelerator Facility for Beams of Ions and Antiprotons', that was submitted last October to the Wissenschaftsrat, the highest scientific advisory committee to the federal government in Germany, for evaluation.

The document concluded a process that had been ongoing for a number of years with extensive discussions, workshops and planning activities by the international science community. I would like to take this opportunity to express our sincerest thanks to the large number of scientists both from inside GSI and from the many universities and research groups worldwide, that have contributed to this important activity for GSI. The report, which has been widely distributed, attempts at the end to list all the individuals involved in this activity. The report itself may be downloaded from the GSI Website (http://www.gsi.de/GSI-Future/cdr/) or can be requested as a CD. Due to the volume of the report and the large range of science discussions and technical concepts presented, we decided not to repeat its content in this annual report (except for some specific ongoing technical developments) but rather refer the interested reader to the full CDR document.

Despite the intense work for the CDR, the ongoing research program went ahead full steam. It took advantage of the improved beam intensities now available from the recent upgrade and from further developments in instrumentation. This is described in the various contributions to the present document. Some selected highlights follow.

In the heavy-element work the most interesting development is perhaps the first chemical study of element 108, hassium. In addition new isotopes of curium, rutherfordium and hassium were discovered. SHIPTRAP, the ion trap after the recoil separator to collect, identify and study heavy nuclei was completed and first on-line tests with stable beams successfully performed.

The study of nuclei far from stability involved a broad range of both, on-line decay studies as well as experiments with energetic radioactive beams. A breakthrough was achieved at the on-line mass separator for the selective and fast ISOL (isotope separation on-line) extraction of tin and germanium isotopes. This is expected to provide novel opportunities for the study of nuclei at and around the doubly-magic $^{100}$Sn. A radioactive beam experiment that drew some attention in the form of a Physical Review front page figure was the study of the spin-orbit splitting in the neutron-rich helium-7 isotope.

In the area of hadron physics two very successful experiments were performed that may have considerable impact on the understanding of hadron properties in nuclear matter. First, by a clever scheme of acceleration, stripping of all electrons, cooling of the resulting poor beam in the ESR, and then reinjection and reacceleration to the highest energy, it was possible to prepare beams of gold ions of 1.5 GeV per nucleon. This allowed for a key study of kaon production in nucleus-nucleus collisions and the related question of the mass shift of kaons in the nuclear medium. Second, in a direct reaction experiment, pionic K-shell atoms were produced and measured for medium-mass tin isotopes. From these measurements one expects precise and seminal information on the s-wave pion-nucleus potential.

In the atomic physics program precision measurements were successfully made, ranging from 1s and two-electron Lamb shifts to a new determination of the electron's mass. For PHELIX, the peta-watt high-energy laser for heavy-ion experiments which is constructed together with the plasma physics group at GSI, a major milestone was reached with the demonstration of the performance requirements for the femto-second front-end.

The broad program of applying ion beams to plasma physics, materials research, and to biophysics and radiation therapy was successfully continued. Highlights from this research are: proton radiography measurements with laser generated high-quality proton beams, applications of ion induced nanopores as model channels of biomembranes or as templates for submicron-sized metal wires, and the observation of a localized protein response to individual particles traversing a cell nucleus. In heavy-ion therapy well over 120 patients have been successfully treated. This corresponds to 250 days of therapy operation and more than 1500 fractions, i.e. radiation treatments.

A wide range of technical developments is underway, aimed at both the short- and mid-term research programs with the present facility and at the long-term program that we hope will be carried out at the future facility discussed above.

Finally, in 2001 a major change was introduced in the funding process for the Helmholtz-Gemeinschaft, the organization of research centers to which GSI belongs. Funding is being changed from institutional to program-oriented funding. In this new scheme program presentation and evaluation will happen on a strategic level every five years. This implies presentation of the GSI research activities in a broader scheme along major research program lines. We intend, nevertheless, to provide the annual status of the detailed research activities in the form of this traditional annual report. Please let us know your views and comments about this.