

PREFACE

This annual report of the *Maier-Leibnitz-Laboratorium für Kern- und Teilchenphysik der Ludwig-Maximilians-Universität München und der Technischen Universität München* (MLL), will summarize the highlights of the local and external work in 2006.

The last year has seen the application and reviewing process of the German *Exzellenzinitiative* in which MLL groups have been particularly successful. The MLL is at the center of the successful cluster of excellence *Origin and Structure of the Universe*, which combines the expertise in the Munich area in Nuclear and Particle Physics, Astrophysics, and Astronomy for a coherent push towards answering a number of fundamental questions concerning the Universe we live in. At the same time there is significant involvement of some of the MLL groups in a second cluster of excellence *Munich Center for Advanced Photonics* MAP.

The contributions in this annual report describe developments for projects at the research reactor FRM II, in particular the ultra-cold neutron source, investigations pursued at external research facilities in which members of the MLL played a major role, experiments performed at the MLL Tandem accelerator, as well as related theoretical investigations.

In the following some of the highlights from the various activities are summarized:

- A major focus of **nuclear structure research** is the study of nuclei far from stability in order to understand the evolution of shell structure, which may significantly change in neutron-rich systems. MLL groups have completed the design studies for the MAFF accelerator, which awaits eventual future funding. The physics program at REX-ISOLDE/CERN using the MINIBALL gamma-ray detector array is continuing with vigor, pushing the limits in terms of neutron richness and mass of the accelerated beams. MINIBALL was also used for spectroscopy at relativistic energies at the GSI FRS. At the local Tandem the unique sensitivity of the Q3D magnetic spectrograph is leading to new discoveries related to the number of excited 0^+ states and excited states in the second and third minimum in the fission isomers. The set-up of the MLL trap system for precision mass measurements is progressing well.
- The Mini-D₂ source for Ultra-Cold Neutrons will perform precision measurements of **fundamental properties of the neutron**, such as its lifetime and the search for an electric dipole moment. While the preparations for an installation at the FRM II are progressing well, first tests of the production scheme at the Mainz TRIGA reactor have been performed very successfully. A number of exciting experiment using an intense cold neutron beam were performed at the FRM II and other neutron sources, such as the ILL and PSI.
- MLL groups are very actively involved in several international collaboration for the **study of the constituents of matter at high energies**. MLL scientists have delivered 88 large drift-tube chambers to the ATLAS detector at the CERN LHC, which are now being commissioned and calibrated to be ready for the approaching LHC start-up. The MLL Cosmic-Ray test-facility is now being used to study possibilities for the future luminosity upgrade of the LHC. At the same time MLL particle physicists play an important role in a precise determination of the top-quark mass as well as searches for physics beyond the standard model using data from the D0 experiment at FNAL. On the theoretical side investigations span from string theory, particle phenomenology, and flavor physics.

- The productive runs of the COMPASS experiment at CERN which will give clues on the **internal structure of hadrons and their excitations** are continuing, leading to a number of major publications, in particular on the gluon contribution to the nucleon spin. Hadron properties in dense and hot nuclear matter are being investigated by the HADES Di-electron spectrometer at GSI, which also has continued its physics program with p+p experiments, while the first publications from the C+C experiments are coming out. A very active theory program is investigating the various aspects of non-perturbative QCD that are investigated with these experiments. A new development is the emerging possibility to connect chiral perturbation theory through extrapolation with lattice QCD results.
- MLL scientists play a leading role in the investigation of neutrinos and searches for dark matter, which is the domain of **astro-particle physics**. At the end of last year the BOREXINO experiment was completed with major MLL contributions and is now taking data, looking at the monoenergetic ${}^7\text{Be}$ neutrinos. Also the CRESST experiment, which searches for weakly interacting massive particles (WIMPs), predicted by supersymmetric theories, is now starting operation in Gran Sasso. Important developments and tests for cryogenic detectors are being performed in the MLL Underground Laboratory and using the neutron beam at the Tandem accelerator.
- The **Tandem accelerator** and its instrumentation are the backbone for the ongoing high quality nuclear physics and interdisciplinary research performed. In the past year the Tandem accelerator has again performed very reliable and steps have been taken to replace several aging components to ensure continuous operation.
- The **interdisciplinary research using nuclear techniques** has been performed very actively at the Tandem accelerator. High resolution ERD and channeling ERD experiments were performed using the Q3D to determine structural properties and surface properties of semiconductors and metal alloys.

The single-ion irradiation of biological cells at the ion beam microscope SNAKE has led to the discovery of competing processes in the repair response of the cell. The modification towards an on-line microscopy of the probes has now been completed. The RadBioMat project is progressing well on the way to produce new materials for use as radioactive implants in brachytherapy.

The world-wide unique sensitivity of the accelerator mass spectrometry AMS has enabled the measurement of very small isotopic ratios of astrophysical, atmospheric, and geological importance. A new focus is the determination of reaction cross-sections relevant for nucleosynthesis.

- The use of laser beams for cooling, production, and acceleration of ions or electrons is at the center of activities in the MAP cluster of excellence centered at the Max-Planck institute for Quantenoptics in Garching.

Through major outside funding and the *Universe* Cluster of Excellence the laboratory is perfectly positioned to keep making major contributions to the fields of particle and nuclear physics. The budget of the MLL provided by the Freistaat Bayern has been the basis for substantial grants by the BMBF, the DFG, the DAAD, the European Union, the Alexander-von-Humboldt Stiftung, and the Bayerische Forschungstiftung. This annual report serves the information of our sponsors, friends, and colleagues about the work of the past year. We would like to thank them for their support.

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