INTRODUCTION
1 April 2000 - 31 March 2001

This volume presents a summary of progress in research and operations at the Texas A&M Cyclotron Institute for the period 1 April 2000 - 31 March 2001. Reports on individual research projects are presented in Sections I-IV. Operation and development activities are reviewed in Section V. The last two sections summarize publications and oral presentations and present additional information on the personnel and activities of the Institute during the report period. Some of the results and conclusions presented in this report are based upon preliminary analyses of data. Until this research is published, these results and conclusions should not be cited without express consent of the investigators involved.

As we made the transition into the (real) new millennium, the continued modernization of our facilities and the Institute research programs were enjoying a very successful period. The program of systematic investigations of superallowed beta decay, our most recent new experimental program, is now firmly established. In July, the first measurement of a precision half-life, that of ^{22}Mg, was made using the new tape-transport system with MARS. Measurements of branching ratios for ^{22}Mg have now been made. Similar measurements are in progress for ^{34}Ar and ^{30}S. Combining these data with mass determinations to be performed with the Canadian Penning Trap at Argonne, will allow determination of precise *ft*-values for all three superallowed transitions. The results will be used to test the charge-dependent corrections that must be applied to all precision superallowed measurements and ultimately to test the unitarity of the CKM matrix.

The Giant resonance group has previously identified two ISGDR components in ^{90}Zr, ^{116}Sn, and ^{208}Pb, one at $E_x \sim 114$ MeV/$A^{1/3}$ which is a compression mode whose energy is dependent on nuclear matter compressibility and a new toroidal surface mode at Ex~ 70/$A^{1/3}$ MeV. The MDM spectrometer has been modified in the last year to considerably increase the uniformity of the field and as a practical matter to allow the detection of more rigid projectiles.The modified spectrometer is now being used to take improved data on the GMR and ISGDR in medium and heavy nuclei. This work emphasizes isotope chains such as ^{112}Sn-^{124}Sn to study the dependence of these resonances on neutron number, derive information on the symmetry energy and look with considerably enhanced sensitivity for weak components of the resonances that might significantly shift their centroids and affect nuclear matter incompressibility determintations.

A ^{8}B beam, produced in MARS using a using a primary ^{9}Be beam from the K500 cyclotron, has been developed to measure elastic scattering from the p-shell nuclei ^{9}Be, ^{13}C and ^{14}N. It is being used to determine optical model parameters for ^{8}B and to study the ^{14}N(^{8}B,^{9}C)^{13}C reaction in order to obtain the Asymptotic Normalization Coefficient for ^{8}B + p $\rightarrow$ ^{9}C which will allow extraction of the astrophysical S-factor for the ^{8}B(p,γ)^{9}C reaction. The ANC technique was developed at TAMU and has become an important technique for nuclear astrophysics. The ^{8}B(p,γ)^{9}C reaction, which is important in the evolution of the early universe, is dominated by direct capture and is thus an ideal candidate for the ANC technique. The ANC method has also been to measure radii of halo nuclei, ^{8}B, ^{13}C and ^{17}F.

In November 2000, a third campaign of experiments was carried out with the NIMROD detector. NIMROD, which has 4B geometry for charged particles and for neutrons, was employed to investigate transparency and isospin equilibration in the reactions ^{58}Ni, ^{58}Fe + ^{58}Ni, ^{58}Fe at 30 and 45 MeV/nucleon, and to follow the dynamic evolution and establish the degree of chemical equilibrium for different entrance channels leading to similar multi-fragmenting systems. An upgrade of the NIMROD detector which includes installation of additional Si detectors in the forward hemisphere and replacement of the current back hemisphere with one half of the Indiana ISiS detector is underway. In a nice example of technology transfer, NIMROD is now using the ROOT based acquisition and analysis software developed for BRAHMS at RHIC.

Detailed measurements of gamma and neutron emission as a function of the mass asymmetry at scission are providing new insights into the potential energy surface for fission of heavy elements and clarifying the role of angular momentum in multi-modal fission. Focus has been on the ^{48}Ca + ^{176}Yb reaction which forms the same compound system as previously studied, i.e. ^{224}Th. The enriched ^{48}Ca was provided by our Dubna collaborators.

The strong theoretical efforts in nuclear structure, nuclear astrophysics, few-body problems, relativistic collisions and the nuclear equation of state - all areas of focus in the Institute – are reported in Section III. Accurate calculations of isoscalar giant dipole resonance strength have carried out. The pressure-temperature-asymmetry surface of equilibrium and the caloric curves for asymmetric nuclear matter have been explored. Exact three body calculations have been developed for several light reaction systems. A multi-phase transport model has been developed for relativistic collisions. Calculations of multi-strange baryon production and baryon number fluctuations have been made.

In the atomic physics programs (Section IV) measurements have been made to test models of projectile and target atomic number scaling of K-vacancy production cross sections and molecular orbital enhancement effects in near symmetric collisions. Energy loss determinations have been made for highly stripped ions. In a collaboration with scientists from Princeton, multiple electron stripping of low energy heavy ions has been studied to evaluate the significance of such processes in fusion energy drivers.

Institute scientists continue to collaborate in experiments at other facilities which have different or complementary capabilities. Measurements of the Michel parameter in normal : decay at TRIUMF (the TWIST collaboration), of half lives and branching ratios for superallowed beta emitters in A > 60 nuclei (the E-823 collaboration) ,also at TRIUMF and QGP studies at RHIC (the BRAHMS collaboration) continued during the year. This report period saw the first collisions at RHIC. Carl Gagliardi and Bob Tribble have now joined the STAR collaboration at RHIC and will work on the development of the EMC end cap construction for the spin physics program with STAR.

We are very pleased to note that in this report period two of our graduate students, Gulnara Ajupova and Doug Rowland, completed their theses and received their PhD degrees from Texas A&M University.

As the cover picture illustrates, development of new research instrumentation over the past decade has greatly increased Institute research capabilities. General development of other parts of the facility infrastructure has also continued. The new computerized control system, installed early last year is now completely operational. Migration of the Institute computer systems from VMS to a Linux based computing structure is well underway. Adoption of the new NSCL data acquisition software is presently under consideration. Our new multiple frequency ECR source, ECR2, was in the commissioning stage when an apparent hot spot led to some degradation of one of the permanent magnets. Evaluations of designs for more efficient cooling are underway. This source is expected to provide a significant expansion of our beam list.

Also in the past year, considerable effort has been devoted to developing the Radiation Effects Line and making its operation more user-friendly. As anticipated, use of this line by the SEU testing community has increased strongly. Approximately 20% of the scheduled beam time was used for radiation testing during the period covered by this report.

As this report is being sent to the printer, we are preparing for installation of the University of Michigan "BigSol" 7 Tesla Super-conducting Solenoid Magnet. This device will be used both for the production of secondary radioactive beams and for research in the areas of reaction dynamics and the properties of isotopes far from stability. The Big Sol solenoid will also be employed at TAMU in experiments designed to evaluate it's effectiveness as the first stage of an ion-guide system to be used in the collection and stopping of radioactive species for re-acceleration in a second accelerator. If these tests are successful we expect to submit a proposal to the U.S. Department of Energy to reactivate our other accelerator, the 88" Cyclotron and use it to produce radioactive species for transfer to, and acceleration in, the K500.

Finally, I wish to express my sincere gratitude to Angela Bostwick and Y.-W. Lui. They assumed responsibility for technical preparation of this report on very short notice and have carried it out with admirable efficiency. I thank them both for their effort and for the high quality of their work.

J. B. Natowitz
June, 2001