Introduction
April 1, 2016 – March 31, 2017

Progress in research and operations at the Texas A&M Cyclotron Institute is summarized in this report for the period April, 1, 2016 through March 31, 2017. The format follows that of previous years. Sections I through III contain reports from individual research projects. Operation and technical developments are given in Section IV. Section V lists the publications with Cyclotron Institute authors and outside users and the Appendix gives additional information including talks presented by members of the Institute during the past year. Once again, the full volume of this year's Progress in Research is available only on our web site (http://cyclotron.tamu.edu). *Since most of the contributions presented here are truly reports on progress in research, results and conclusions should not be quoted from the report without the consent of the authors.*

We are pleased to announce that Dr. Che-Ming Ko was named a Distinguished Professor, Dr. Saskia Miodeusewski was promoted to full Professor and Dr. Jeremy Holt was awarded an NSF CAREER Award. Dr. Joseph Natowitz and Dr. Dave Youngblood both retired after 50 years on the faculty.

The K500 provided an impressive 6,200 hours of beam for both science and radiation effects testing. The K150 cyclotron provided again, a record 3,800 hours of beam on target and is now being used by external users for radiation effects testing with its proton beams. The list of beams from the K150 included protons (strip extracted), deuterons (strip extracted), ^{4}He, ^{10}B, ^{19}F, ^{22}Ne, ^{23}Na, ^{25}Mg and ^{28}Si. Proton beams from the K150 (strip extracted) are now available from 3 MeV to 50 MeV. Also, the K150 ^{4}He beam is of note because 5 particle-microamps of beam at 7.2 MeV/u were provided on target for the production of ^{211}At from ^{4}He+^{209}Bi. Progress was made with the light-ion guide (LIG) project in that ^{64}Ga 12+ ions were produced, charge-bred and extracted from the charge-breeding ECR source (CB-ECR). Also, this year, the K150 and K500 cyclotrons were used together for the first time to attempt to produce and re-accelerate the ^{64}Ga 12+ radioactive ions.

As in previous reports, I include here some highlights of work carried out over the past year.

- We have settled a longstanding controversy over the calculation of Internal Conversion Coefficients (ICCs): Should the effects of the vacancy in the atomic shell left behind by the departing conversion electron be accounted for or not? By making precise measurements of ICCs for E3 and M4 transitions in eight nuclei spanning the range $47 < Z < 79$, we have been able to distinguish between results from the two methods used to calculate ICCs, and have unequivocally demonstrated that the vacancy effects must be included. This result has already impacted the way in which ICCs are being calculated by the National Nuclear Data Center.

- We have commissioned the TIARA detector array, coupling it to the MDM and four HPGe clovers.

- We have completed a four-experiment science campaign with TIARA, constraining important reactions in nova nucleosynthesis and the S-process.

- A new method for indirect radiative capture reactions that allows one to measure (p,γ), (α,γ) and (n,γ) astrophysical radiative capture reactions on stable and unstable isotopes has been suggested. A special attention is given to the "holy grail" reaction $^{12}C(\alpha,\gamma)^{16}O$.

- RHIC gluon polarization measurements were identified as the BNL research highlight in the 2016 Annual Report on the State of the DOE National Laboratories.

- A new method has been developed to resum the interaction contribution to the equation of state of strongly coupled systems in the Luttinger-Ward-Baym formalism. When applied to the quark-gluon plasma using interactions constrained by lattice QCD, large collisional widths dissolve the quark and gluon quasi-particles while broad hadronic bound states emerge as the dominant degrees of freedom near the critical temperature.

- A previously developed rate equation approach for quarkonium kinetics in hot QCD matter has been deployed to bottomonium production in heavy-ion collisions, including in-medium binding energies and dissociation rates.

- The strong suppression of the Υ(2S) observed at the LHC provides a clean signal of deconfinement, while the suppression of Υ(1S) states yields a measure of color screening of the short-distance QCD force.

- Recent experiments on In and Tl extraction into either betainium-based fluorinated ionic liquids or carboxylic acid-based deep eutectic mixtures from hydrochloric acid media have shown promising results for an effective transfer of these elements into an organic phase, which is beneficial for a future chemical study of their heavy homolog nihonium (Z = 113).

- The heavy elements group has studied the reactions of ^{40}Ar with lanthanide targets, and cross sections were measured for the complete fusion, neutron evaporation channels. Preliminary results indicate that the data are consistent with previous results, and further strengthen the argument that the production of new superheavy elements will be very difficult.

- The NZ equilibration curve for the dynamical component is consistent with the overall NZ equilibration curve in deformed projectile-like fragments.

- Using the Gibbs-Tolman-Widom concept of sharp equimolar surface we have derived the

pressure and equation of state for finite nuclei within the extended Thomas Fermi approximation for the energy density functional.

- We have developed a method for unitarity restoration in the nuclear spectral function by modifying the optical model green function and applied it in the study of the isoscalar giant monopole resonance.

- With the nuclear polarization of laser-cooled atoms at TRINAT determined to be 99.13(9)%, we have made a 0.3% measurement of the beta asymmetry parameter, A_β. This is the most precise relative measurement of a polarized angular distribution parameter in any nuclear system, including the neutron.

- A prototype cylindrical Penning trap, 80 mm in diameter, has been installed and commissioned. We have demonstrated trapping of stable K and Na and the ability to excite the ion motions. Resonance scans have been made demonstrating mass-resolving powers at the ppm level.

- A study based on an extended relativistic Vlasov–Uehling–Uhlenbeck transport model, which includes both the pion in-medium effects and the in-medium threshold effects on Delta resonance production and decay, has shown that to reproduce the available experimental data on charged pion ratio in high-energy heavy ion collisions requires a nuclear symmetry energy that has a density slope of about 59 MeV at normal nuclear matter density, consistent with current constraints from other observables.

- A new method for automated particle identification of charged particle in ΔE-E telescopes has been developed.

Institute scientists remain active in a number of collaborative research efforts around the world. Major programs include: mass measurements using the Penning Trap at the University of Jyväskylä; continued work with the STAR collaboration at RHIC; measurements of beta decays with the TRINAT collaboration at TRIUMF; ANASEN at MSU; and participation in the SAMURAI collaboration at RIBF in Tokyo, Japan.

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