Expanding the weak interaction program – a general purpose ion trapping station

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A new program on studying the weak interaction via precision β-decay measurements has begun at the Cyclotron Institute. With the upgrade of the facilities here, there are many exciting new opportunities for studying the properties of nuclei off the valley of stability. Penning traps offer a powerful tool to study these exotic nuclei due to their ability to purify and confine any species of ions in small volumes for long periods with a high degree of control. Ions in this type of trap are confined in 2D via the application of a strong magnetic field, and an electrostatic field is applied so as to trap the atoms in the third dimension. The versatility of these traps is evident by the number that are in use or planned for precision studies at every major rare isotope beam (RIB) facility. To capitalize on the increased RIB capability of the upgraded Cyclotron Institute, we are building a dedicated beam line system to guide low-energy ions from the heavy-ion gas catcher ending to a cylindrical Penning trap β-decay station. The ions in this trap will be purified (potentially with a mass-resolving power of up to 800,000), cooled and bunched. Decay studies of the the trapped ions may be performed *in situ* (e.g. β-ν correlation studies), or the low-emittance beam from the trap may be used for nuclear spectroscopy, lifetime and branching ratio measurements.

The initial goal of the program utilizing this decay station is to measure the *ft* values of T=2 superallowed β-delayed proton emitters. The T=2 nuclei are especially interesting because a recent comparison of isospin-mixing corrections by I. Towner [1] indicate a systematic dependence with isospin with the type of model used (either a Woods-Saxon plus Coulomb potential or a self-consistent Hartree-Fock calculation). To test the calculations and add new cases from which V_{ud} may be extracted requires measurements of the *ft* value to the sub-percent precision. For the β-delayed proton emitters, this corresponds to measuring the proton and γ branching ratios from the 0^+ state as well as the lifetime, all to the sub-percent level. A proof-of-principle measurement on ^{32}Ar has been demonstrated [2], and we plan to refine this measurement with the clean Penning trap system. Once the technique is refined and the *ft* value of ^{32}Ar is improved to $\lesssim$ 0.5%, the program will continue measuring a number of other T=2 nuclei as well as branching out into measuring β-ν correlations in these nuclei via the Doppler-broadened proton energy spectrum.

With a DOE-sponsored capital grant, we have recently ordered the 7 Tesla, 16 cm actively shielded bore magnet from Magnex Scientific for the planned Penning trap which is expected to arrive by the end of this year or early 2011. At present, design of the beam lines and decay station using the ion-optics simulation package SIMION8.0 is in progress.

[1] Ian Towner, private communication.
[2] M. Bhattacharya *et al.*, Phys. Rev. C **77**, 065503 (2008).