WITCH: Testing the Standard Model using a beta-recoil spectrometer with a trapped ion cloud as source

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The fundamental coupling constants of the electro-weak interaction have presently been determined only with precision that leaves much room for effects beyond the standard model. In the low-energy regime nuclear beta decay is the most abundant weak interaction phenomenon, but in spite of this only rare cases have allowed precision measurements of the abovementioned constants. An important limitation is the spread in daughter recoil energies caused by the source thickness, if the daughter ions get out of the source at all.

The use of an ion cloud in a trap as source is a novel and generally applicable way around this problem. In this presentation a retardation spectrometer with such a source is described. Bunching and mass-selective cooling of the ions takes place in a first trap, from which the ions are released into the decay trap. Recoiling daughter ions with energy enough to pass a retardation voltage are detected on a micro-channel plate. The necessary acceptance is achieved by a reversed magnetic-mirror principle, adiabatically transforming the radial energy of recoils into axial ditto. This happens in a transition region from a 9T magnetic field, due to a super-conducting magnet system, to a weaker field of 0.1 T.

Presently, the WITCH set-up is under construction at ISOLDE , CERN. The extraordinary range of isotopes available there will allow the most suitable source isotopes to be selected. In addition, other phenomena, such as electron shake-off in the beta decay process, will be amenable to study with this ion-trap and spectrometer system.

First experiments testing the principle are planned for 2003. Then, pure Fermi transitions will be probed for possible scalar contributions.