Development of a Momentum Analyzing Beta Spectrometer for ^{14}O and ^{8}B

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We are developing a beta spectrometer at the Lawrence Berkeley National Laboratory 88−inch Cyclotron. The spectrometer is a 180° flatfield dipole magnet, and is mounted with a proportional wire chamber constructed at LBL in 1999. The magnet can produce fields of up to 6 kG, which allows a measurement of beta spectra with endpoint energies up to 18 MeV. Beta particles with radii of curvature between 4.8 and 11.2cm may be observed with the wire chamber, which gives a momentum bite of (delta P)/P = 0.57, which is larger than the momentum bite offered by previous detectors which have been used with this spectrometer. The spectrometer has an acceptance of roughly 5 x 10^{-5} of the sphere. The wire chamber is composed of five wire planes with a planar spacing of 3mm and offers position resolution in two dimensions. There are 64 sense wires for vertical resolution and 16 wires for horizontal resolution. The sense wire spacing is 2mm. A 50/50 Argon/Ethane gas mixture is bubbled through isopropyl alcohol and continuously flowed through the chamber at atmospheric pressure. The two sense planes are held at ground while the three high voltage planes have potentials up to 3kV for proportional chamber operation. Signals collected from the sense wires are amplified and discriminated using custom electronics. Two experiments scheduled for PAC periods in 2002 will be performed with this spectrometer. One is a precise measurement of the spectral shape factor in ^{14}O beta decay as part of a test of the Conserved Vector Current Hypothesis in the A=14 system. A measurement of the shape factor requires 10^7 observed decays, which demands a rate of over 10^6 ^{14}O produced per second. Such production rates have been achieved using the IRIS ECR source, and the spectrometer has recently been mounted near the IRIS beamline. A transfer arm has been assembled to shuttle the ^{14}O from the beamline to the spectrometer acceptance region after it has been implanted into a thin carbon foil. The second experiment is a measurement of the ^{8}B beta spectrum. This experiment would utilize a large magnetic field (5 kG) to observe the high energy portion of the ^{8}B beta spectrum (which has an enpoint energy of about 15 MeV). Such a measurement would indirectly probe the shape of the neutrino spectrum of ^{8}B, since both the beta and neutrino spectra differ from the allowed shapes due to the presence of the alpha−unstable daughter nucleus ^{8}Be. This measurement should assist in the interpretation of the observed ^{8}B solar neutrino spectra in water Cerenkov detectors such as SuperK and SNO. The ^{8}B will be produced online at the 88−inch Cyclotron using the $^{6}Li(^{3}He,n)^{8}B$ reaction. A precise momentum calibration of the spectrometer is neccesary for the results to be useful, because the discrepancies among previous laboratory data in the mass−8 decay chain is due to energy offsets among the observed spectra. Calibration will be performed using other high energy positron decays, in particular ^{20}Na (E_{max} = 11 MeV) and ^{12}N (E_{max} = 15 MeV), which are allowed decays and hence have spectral shapes which are well known. These isotopes would also be produced online at the 88−inch Cyclotron using the $^{20}F(p,n)^{20}Na$ and $^{3}He(^{10}B,n)^{14}N$ reactions.

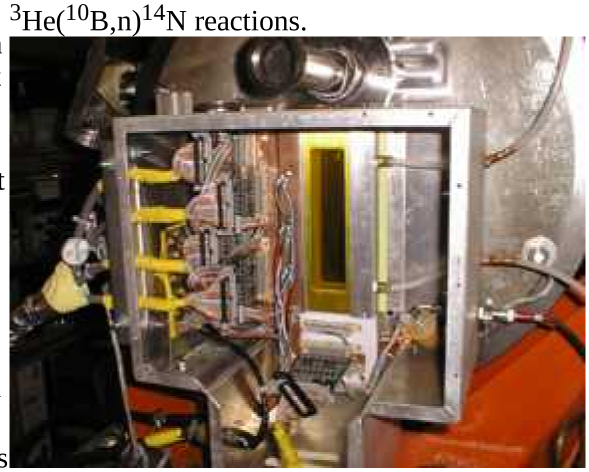

Figure 1. Photograph of the beta spectrometer.