MEASUREMENTS OF SPIN-DIPOLE STATE ANALYZING POWERS FROM THE REACTION $^{12}C(\vec{d},^{2}He)^{12}B$

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Charge-exchange reactions employing the (p,n) and (n,p) reactions have proven to be powerful, quantitative probes of nuclear structure and reaction dynamics.[1–4] Of these two reactions the latter is experimentally more complicated, since it involves a secondary beam, and therefore rather poor statistics or resolution have to be accepted. The (d,^{2}He) reaction, where ^{2}He denotes a diproton $^{1}S_0$ state, can offer a way out of this dilemma. It allows beam intensities orders of magnitude higher, substantially better energy resolution, and use of considerably less target material than the (n,p) reaction. In addition, it facilitates spin polarization studies, which up to now have not been feasible for the (n,p) reaction. Since the reaction is dominated by a single-step transition from a $^{3}S_1$ state (d) to a $^{1}S_0$ state (^{2}He), the process populates spin-flip $\Delta S = 1$ charge exchange only, without any need for polarized beam. Second, by measurement of the vector and tensor analyzing powers, it is in principle possible to identify total spins of states of the residual nucleus without need for polarimetry.[5] The main drawback, however, of the (d,^{2}He) reaction is that the reaction mechanism is not as well known as in the (n,p) case. Hence, to carry out useful (d,^{2}He) studies, it is first necessary to "calibrate" the reaction in various ways. The current experiment is aimed at just such a calibration of vector and tensor analyzing powers for reactions leading to known states.

The most suitable target providing a useful range of transitions is ^{12}C. The 1^- state of ^{12}B at 2.62 MeV and the 2^- at 1.67 MeV should serve as A_{yy} calibration states for spin-dipole transitions. An additional objective of the experiment is to attempt to identify the 0^- state (for which A_{yy} should be identically 1 at all angles). This transition, which has never been identified, is of special interest since it is the true pionic mode.[6]

In Fig. 1 the experimental facility is sketched. The 6° magnet on the T section of the Cooler bends the protons out of the deuteron beam. A magnetic channel, consisting of two dipoles and three quadrupoles, provides additional bending and focussing of the protons onto a segmented germanium telescope. Three plastic scintillators, one in front of the first dipole and two in front of the germanium detector, are used for triggering. A wire chamber in front of the first dipole gives the reaction angle, and a second wire chamber is used to determine the point of entry into the germanium telescope.

For most of the proton flight path, the trajectories are in vacuum or helium to reduce the energy straggling. Luminosity monitors using four NaI(Tl) detectors, are located on the opposite side of the beam line.

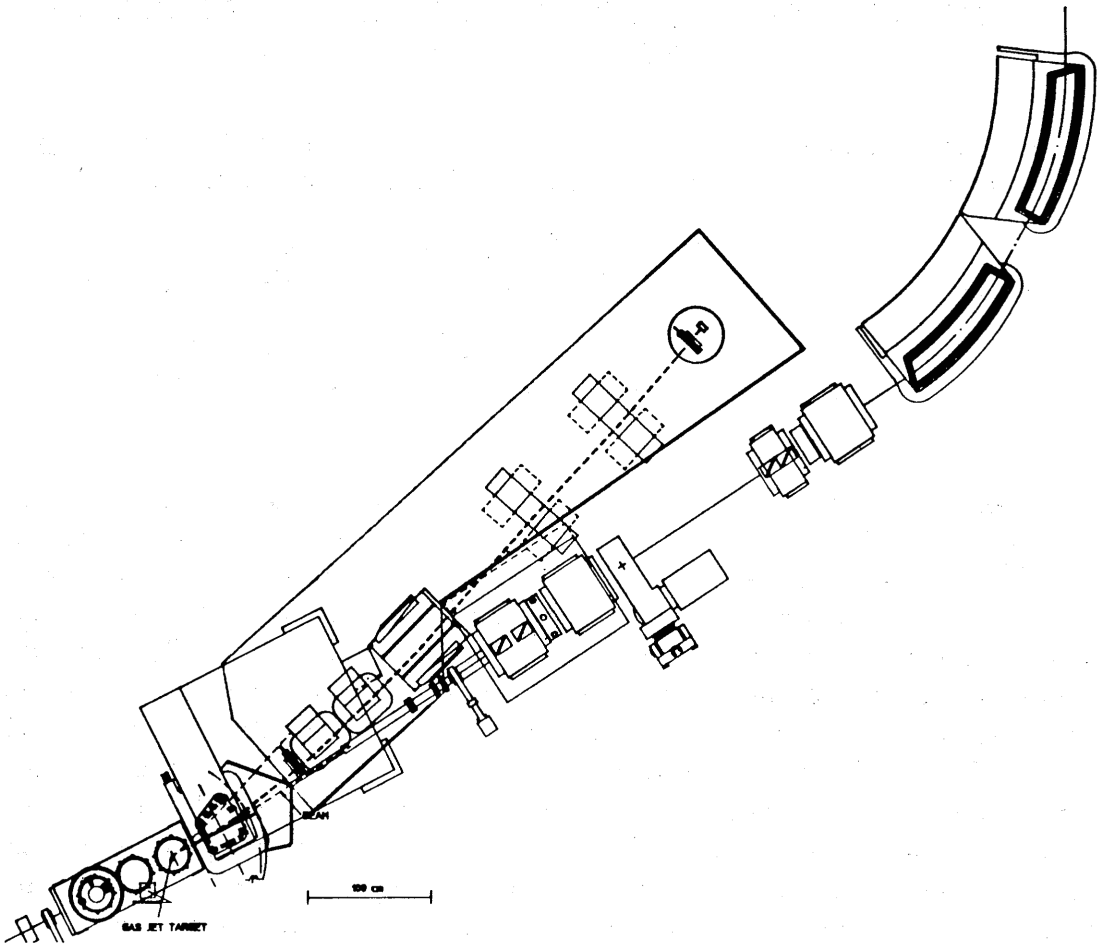

Figure 1. Overview of the experimental facility.

The setup has about a 4° horizontal acceptance, which implies that the angular range of interest, $-1°$ to $+15°$, can be covered by four or five detector settings. The total energy and angular resolution is expected to be 300 keV and 0.3°, respectively. A test run of 9 shifts is planned in December 1992, with the production run of 27 shifts in the beginning of 1993.

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