Fast Tape-Transport System

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The fast tape-transport system, first described in last year's Progress Report [1], has been built and commissioned (see figure).

Its design is an upgraded version of a system developed over a number of years at Chalk River [2,3]. Unlike that system, however, it operates entirely in air since it is intended for use with the relatively energetic separated beams from the MARS recoil separator. Once a particular separated beam has been optimized on the focal plane of MARS, it is allowed to exit the vacuum chamber through a 51-μm-thick kapton window. It then passes through a thin scintillator and adjustable aluminum degraders before stopping in the aluminized-mylar tape, which is 76-μm thick by 2.54-cm wide. Tests with a 25 MeV/nucleon ^{22}Mg beam show that, under these conditions, ≥99% of the ^{22}Mg atoms stop within the tape. At typical intensities of approximately 10,000 atoms/s, the scintillator detects the atoms individually before they reach the tape, thus precisely determining the number of atoms in each collected sample.

Fresh tape is wound on a reservoir reel that can accommodate a maximum diameter of 30 cm. It is connected from the reservoir reel, past the vacuum chamber at the MARS focal plane, to the counting location, and on to the take-up reel. Strategically located air bearings ensure that the tape moves smoothly along this path, which can extend over 3 m or more. The two reels are mounted independently on separate decks, each with its own vacuum buffer and controls, thus making the system very flexible in adjusting to various experimental geometries. Furthermore, the height of each tape deck is adjustable (by motor drive) between 1.20 m and 1.60 m to accommodate to different angular settings for the last stage of MARS.

The tape is operated in discontinuous mode, with a collection period followed by a rapid tape move and then a counting period. The times for these three periods can be set by thumbwheels on a control panel on one of the tape decks, or they can be controlled by external computer-generated signals input to the controller. Normally, the cyclotron beam is pulsed so that it is on only during the collection period. The tape is moved by engaging a pinch roller, which presses it against a 2.54-cm-diameter capstan rotating at a regulated 3800 rpm. Immediately after the pinch roller is released, the tape is stopped promptly by two brakes, one on either side of the counting location, which close in sequence to stretch the tape tightly in front of the detectors. The distance moved by the tape is determined by the pre-set time between the engagement of the pinch roller and the closing of the brakes; once set, this distance has been found to be reproducible from cycle to cycle within ±2 mm.

With the counting location outfitted for measurements on superallowed $0^+ \rightarrow 0^+$ beta decay [4], the distance between it and the collection point is 80 cm. The sample transfer can be accomplished in less than 200 ms at the operating speed of about 5 m/s. This will allow us to study nuclides with half-lives down to about 100 ms.

The tape-transport system was extensively tested and optimized off-line, before an on-line test was performed with ^{22}Mg ($t_{1/2}$ = 3.86 s) produced in the reaction ^{1}H (^{23}Na, 2n) ^{22}Mg at 28*A* MeV. During the on-line run, difficulty was encountered with the tape servo-motors, which failed. The motors were replaced and changes made to the electronics to reduce the feedback to the servo-motors during the relatively lengthy collection and counting periods, when there is no need for rapid response. In a second test run with ^{22}Mg, the tape system worked flawlessly for several days.

The only remaining shortcoming is that the tape reels cannot be filled to 30-cm diameter, their design goal. If a reel is filled to more than about 25 cm, the rapid back-and-forth motion from the servo-motor acts to move an outer annulus of tape relative to the inner core, causing damage to tape at the interface. For now, this limits us to a total length of about 600 m of tape, which, in the case of the ^{22}Mg experiment, means that the tape must be rewound every two hours. This is not a serious limitation since the unit stops automatically when clear leader is detected at the end of the tape; and a complete rewind can be controlled remotely, taking less than 5 minutes in total.

References

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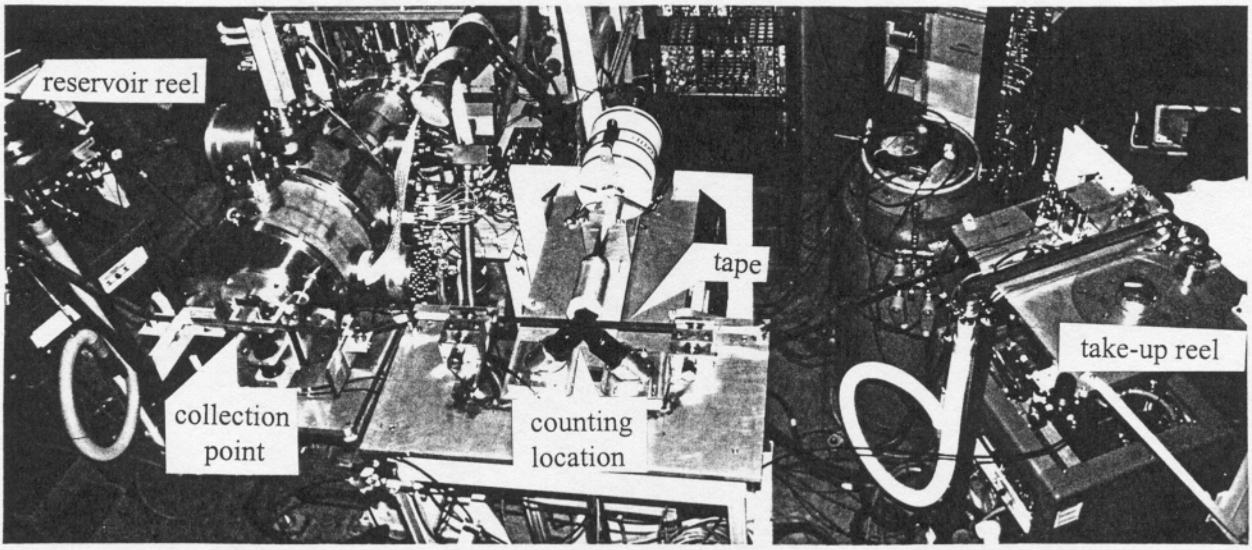

Figure 1: Fast tape-transport system installed at the end of the MARS spectrometer with detectors in place for branching-ratio measurements.